

CLAIMS

1. A method for performing a treatment on a volume located at area and depth coordinates of a patient's skin including:

providing a radiation source; and

5 applying radiation from said source to an optical system which concentrates said radiation to at least one depth within said depth coordinate and to selected areas within said area coordinates of said volume, said at least one depth and said selected areas defining three dimensional treatment portions in said volume within untreated portions of said volume.

10 2. A method as claimed in claim 1 wherein the ratio of said treatment portions to said volume is between 0.1% and 90%.

3. A method as claimed in claim 2 wherein said ratio is 10% to 50%.

4. A method as claimed in claim 2 wherein said ratio is 10% to 30%.

15 5. A method as claimed in claim 1 wherein said treatment portions are one of cylinders, spheres, ellipsoids, solid rectangles or planes of at least one selected size and thickness.

6. A method as claimed in claim 1 wherein said treatment portions are spaced lines of a selected length and thickness.

20 7. A method as claimed in claim 1 wherein said optical system applies said radiation to all said treatment portions substantially simultaneously.

8. A method as claimed in claim 1 wherein said optical system applies said radiation to at least selected said treatment portions sequentially.

9. A method as claimed in claim 1 including precooling the patient's skin over at least one treatment portion to a selected temperature for a selected duration.

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10. A method as claimed in claim 9 wherein said selected temperature and duration for said precooling step are sufficient to cool said skin to at least a selected temperature below normal body temperature to at least said at least one depth.

11. A method as claimed in claim 10 wherein said skin is cooled to at least said
5 selected temperature to a depth below said at least one depth, whereby said at least one treatment portion is substantially surrounded by cooled skin.

12. A method as claimed in claim 11 including continuing to cool the patient's skin during said applying step.

13. A method as claimed in claim 11 wherein the duration of said applying step
10 is greater than the thermal relaxation time of treatment portions.

14. A method as claimed in claim 1 wherein wavelength for said radiation source is selected so as not to be either highly absorbed or scattered in the patient's skin above said volume.

15. A method as claimed in claim 1 wherein, for deeper depth coordinates, said
15 optical system focuses to a selected depth below said at least one depth in order to achieve concentration at said depth coordinate in the patient's skin.

16. A method as claimed in claim 1 including detecting selected conditions in at least one of said volume and the patient's skin above said volume, and utilizing results of said detecting during said applying step to control the treatment portions to which said
20 radiation is concentrated.

17. A method for performing a treatment on a volume located at area and depth coordinates of a patient's skin including:
providing a radiation source;
precooling the patient's skin over at least part of said area coordinate to a
25 selected temperature for a selected duration, said selected temperature and duration being

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sufficient to cool said skin to a depth below said depth coordinate to a temperature below normal body temperature; and

applying said radiation to an optical system which concentrates said radiation to at least one depth coordinate and to selected areas within said area coordinates to define treatment portions in said volume, said treatment portions being less than said volume, each
5 said treatment portion being within untreated portions and being substantially surrounded by cooled skin.

18. A method as claimed in claim 17 including continuing to cool the patient's skin during said applying step.

10 19. A method as claimed in claim 17 wherein the duration of said applying step is greater than the thermal relaxation time of each treatment portion.

20. A method as claimed in claim 1 wherein said radiation source has an output the wavelength of which is at least in part a function of said at least one depth.

21. A method as claimed in claim 20 wherein the applied radiation has a
15 wavelength which is selected as a function of said at least one depth as follows: depth = .05 to .2 mm, wavelength = 400 – 1880 nm & 2050-2350 nm, with 800-1850 nm & 2100-2300 nm preferred; depth = .2 to .3mm, wavelength = 500-1880nm & 2050-2350nm, with 800-1850 nm & 2150-2300 nm preferred; depth = .3 to .5 mm, wavelength = 600-1380 nm & 1520-1850 nm & 2150-2260 nm, with 900-1300 nm & 1550-1820 nm & 2150-2250 nm
20 preferred; depth = .5 to 1.0 mm, wavelength = 600-1370 nm & 1600-1820 nm, with 900-1250 nm & 1650-1750 nm preferred; depth = 1.0 to 2.0 mm, wavelength = 670-1350 nm & 1650-1780 nm, with 900-1230 nm preferred; depth = 2.0 to 5.0 mm, wavelength = 800-1300 nm, with 1050-1220 nm preferred.

22. A method as claimed in claim 1 wherein a vascular lesion at a selected depth
25 is being treated, treatment parameters, including the optical system and the wavelength of the applied radiation, being selected so that said at least one depth is the depth of the vessel being treated.

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23. A method as claimed in claim 1 wherein the treatment is skin remodulation , by treatment of collagen, treatment parameters, including the optical system and the wavelength of applied radiation, being selected so that said at least one depth is at the depth of interdermal collagen.

24. A method as claimed in claim 1 wherein the treatment is hair removal, the treatment parameters, including the optical system and the wavelength of the applied radiation, being selected so that said at least one depth is at the depth at least one of the bulge and matrix of each hair follicle.

25. A method as claimed in claim 1 wherein the treatment is removal of one of tattoos and pigmented lesions, said treatment portions being within the tattoo/pigmented lesion being treated, at least two treatments, each with a selected treatment portion pattern being performed.

26. A method as claimed in claim 1 wherein the treatment acne by damage to sebaceous glands, treatment of intradermal parasites, and treatment of various skin blemishes.

27. Apparatus for performing a treatment on a volume located at area and depth coordinates of a patient's skin including:

a radiation source; and

an optical system to which radiation from said source is applied, said optical system concentrating said radiation to at least one depth in said volume and to selected areas of said volume, said at least one depth and said areas defining three dimensional treatment portions in said volume within untreated portions of said volume.

28. Apparatus as claimed in claim 27 wherein the ratio of said treatment portions to said volume is between 0.1% and 90%.

29. Apparatus as claimed in claim 28 wherein said ratio is 10% to 50%.

30. Apparatus as claimed in claim 29 wherein said ratio is 10% to 30%.

31. Apparatus as claimed in claim 27 wherein said selected portions of said volume are one of cylinders, spheres, ellipsoids, solid rectangles and planes of a selected size and thickness spaced by a selected distance.

32. Apparatus as claimed in claim 27 wherein said selected portions of said
5 volume are spaced lines of a selected length and thickness.

33. Apparatus as claimed in claim 27 wherein said optical system includes an array of optical elements to at least a plurality of which radiation from said source is simultaneously applied, each said optical element concentrating said radiation to a selected treatment portion of said volume.

10 34. Apparatus as claimed in claim 33 wherein each of said optical elements focuses to a line of selected length and thickness, the lines for some of said elements being at a selected angle to the lines for other of said elements.

35. Apparatus as claimed in claim 27 wherein said optical system includes
15 apparatus for scanning radiation applied to optical concentrating components so as to successively focus said radiation to N of said treatment portions at a time, where $N \geq 1$.

36. Apparatus as claimed in claim 27 wherein said optical system includes adjustable depth optical focusing components, and a positioning mechanism for said optical focusing components which moves the component to focus at successive treatment portions.

20 37. Apparatus as claimed in claim 27 including a mechanism which cools the part of the patient's skin at least over said selected area coordinate to a selected temperature, and controls for selectively operating said mechanism to at least one of precool said part of the patient's skin for a selected duration before application of radiation and during application of radiation.

25 38. Apparatus as claimed in claim 36 wherein said mechanism and controls precool said skin to a temperature and for a duration sufficient to cool the part of the skin to

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at least a selected temperature below normal body temperature to at least said at least one depth.

39. Apparatus as claimed in claim 37 wherein said skin is cooled to at least said selected temperature to a depth below said at least one depth, whereby each said treatment
5 portion is substantially surrounded by cooled skin.

40. Apparatus as claimed in claim 27 wherein said source generates radiation at a wavelength which is neither highly absorbent nor highly scattering in at least the parts of the patient's skin above said volume.

41. Apparatus as claimed in claim 27 wherein, for deeper depth coordinates, said
10 optical system concentrates to a selected depth below said at least one depth in order to achieve concentration at said depth in the patient's skin.

42. Apparatus as claimed in claim 27 including a detector for at least one selected condition in at least one of said volume and a part of the patient's skin above said volume, said optical system operating in response to said detector to control the treatment portions of
15 said volume to which said radiation is concentrated.

43. Apparatus for performing a treatment on a volume located at area and depth coordinates of a patient's skin including:

a radiation source;

a mechanism which cools the patient's skin over said area coordinate to a
20 selected temperature;

controls for selectively operating said mechanism to at least one of precool said skin for a selected duration before application of radiation and during application of radiation, said mechanism and controls cooling to a temperature and for a duration sufficient to cool said skin to at least a selected temperature below normal body temperature
25 to at least a depth below said depth coordinate; and

an optical system to which radiation from said source is selectively applied, said optical system concentrating said radiation to a depth in said volume and to selected

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areas of said volume to define treatment portions, said treatment portions being less than said total volume, each said portion being substantially surrounded by untreated and cooled skin.

44. Apparatus as claimed in claim 43 wherein said radiation is applied to said
5 optical system for a duration which is greater than thermal relaxation time of each portion.

45. A method for performing a therapeutic treatment on a patient's skin by
concentrating applied radiation of selected wavelength at a plurality of selected, three-
dimensionally located, treatment portions, which treatment portions are within non-
treatment portions.

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dimensionally located, treatment portions, which treatment portions are within non-
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